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ORIGINAL ARTICLE

Characteristics of Post-Neurosurgical Nosocomial Bacterial Meningitis in Adults: A retrospective Cross-Sectional Study

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ABSTRACT

Aim: To analyze the characteristics of Post-neurosurgical nosocomial bacterial meningitis in adults

Study design: A retrospective cross-sectional study

Place and duration: Riyadh Care Hospital/ National Care Hospital, from July 2005 to June 2010 then 2013 to 2018.

Methodology: Over ten years, sixty-two patients above the age of 16 years who suffered from Post-neurosurgical nosocomial bacterial meningitis were evaluated by collecting clinical data. The cases were divided into two categories, the first one from July 2007 to June 2012 and second one from August 2013 to July 2018.

Results:

Among the 62 patients, there were 43 males and 19 females with post-neurosurgical nosocomial bacterial meningitis. It was recorded in the first group that the percentage of post-neurosurgical nosocomial meningitis in all culture-proven adult bacterial meningitis was 12 percent and for the second group it was seen to be 27 percent.

The most constant clinical characteristics were fever and gradual consciousness disruption, which may be related to various postoperative neurosurgery issues. The most prevalent pathogens were recorded to be pseudomonas aeruginosa, staphylococcus aureus, coagulase-negative staphylococcus, Acinetobacter baumannii, and lastly, Escherichia coli. During the second era, there was a rise in polymicrobial illnesses and multi antibiotic resistance. Mortality was 22% in the first group of the study and 36% in the second group of the study.

Conclusion: The selection of appropriate empirical antibiotics is complex and is necessary to be guided by knowledge of the comparative ratio of multiple diseases as well as the rising prevalence of resistant strains. To increase the likelihood of survival, early diagnosis is suggested with optimal antibiotic selection based on in vitro susceptibility testing, epidemiologic patterns, and lastly, metabolic derangement treatment to be advised and required.

Keywords: Bacterial Meningitis, adults, post-neurosurgery

INTRODUCTION

After neurosurgical operations, bacterial meningitis is uncommon although it has been seen to have risen. The most common procedures that are seen to be the cause of post-neurosurgical meningitis include ventriculoperitoneal shunt placement, lumbar decompression, epidural anesthesia, and craniotomy. However, prophylactic antibiotic is commonly prescribed before neurosurgical operations, its utility has been called into question. (1) The rising cases of neurosurgery operations may be to blame in recent years, for the use of antibiotics to treat upper respiratory tract infections, thus the incidence and clinical range of post-neurosurgical meningitis have shifted.

METHODOLOGY

The method used was through previously designed standardized evaluation forms of the medical records of patients diagnosed with bacterial meningitis following neurosurgical surgery which were then assessed retrospectively that had been given treatment at Riyadh Care Hospital/ National Care Hospital, Riyadh from July 2007 to June 2012 then August 2013 to July 2018. Permission was taken from the ethical review committee of the institute.

These patients' CSF and blood culture, microbiological data were also evaluated. The treatment offered at the Hospital is both primary and tertiary including a 500-bed acute-caring teaching hospital. The number of neurosurgery procedures conducted throughout the study in the hospital was recorded to be 15020 which included ventriculoperitoneal shunt placement (222), ventriculostomy, craniectomy (1298), and craniotomy.

Two groups were made from the patients for study and comparison, first included the group that was from July 2007 to June 2012 then August 2013 to July 2018. The recorded occurrences of culture-proven bacterial meningitis in the study were 267 in patients of 16 years and above, out of which 73 were from the first group and 194 from the second. A total of 62 patients out of 267 were diagnosed with having post-neurosurgical nosocomial bacterial meningitis from those 62, 9 patients were from the first group and the remaining 53 were from the second group.

The criteria used to make a clear diagnosis of bacterial meningitis was as follows, pleocytosis with generally polymorphonuclear cells, classical clinical manifestations such as fever, altered sensorium, typical CSF findings of a decreased glucose concentration increased lactate and protein concentrations, evidence of a bacterial pathogen in one or more CSF cultures and lastly signs of meningeal irritation. (2. 3) Recurrent Meningitis can be either it was caused due to two reasons, if it was caused through the same organism however took place more than 3 weeks after the first episode of meningitis was treated or it was caused through a different organism than the first diagnosis of meningitis.

Etiologic agents were identified if they were recorded frequently or seen to cultivate on a neurosurgical device more specifically the indwelling tip, these agents include, propionibacteria isolated from CSF or coagulase-negative staphylococci, and Diphtheroid. When 2 or more than that, bacterial species were recovered from initial CSF cultures, the patient was diagnosed with mixed bacterial meningitis. The study included patients with the help of analysis by using initial clinical and laboratory data acquired, who were transferred later on in their treatment to the hospital for additional therapy. Patients having simultaneous chronic meningitis or encephalitis that was not caused by bacterial infections were excluded from the study.

Constituent "post-neurosurgical nosocomial bacterial meningitis" was utilized in this study to refer to individuals who were admitted to the hospital after suffering head trauma or undergoing neurosurgical operations. Hydrocephalus was diagnosed clinically and radiologically, necessitating the presence of large ventricles without sulcal enlargement and an altered degree of consciousness.

Antibiotic susceptibility was determined with the help of the Kirby-Bauer disc diffusion method. Another method used in the study to investigate the hanging susceptibility of isolated bacteria was the well-established Vitek Technique, which yields minimum inhibitory concentration data. (4, 5) If the cultures included Streptococcus pneumonia, and the Etest technique was used to evaluate antibiotic susceptibility." Appropriate antimicrobial treatment" was defined as the administration of one or more antimicrobial drugs that have been proved by susceptibility testing to be effective against bacterial infections and capable of passing across the blood-brain barrier in sufficient proportions. Several sets of blood cultures with isolation of bacterial pathogens are defined as Bacteremia. (6). SPSS version 22 was used for data analysis.

RESULTS

Among the 62 patients, there were 43 males and 19 females. It was recorded in the first group that bacterial meningitis was 12 percent and for the second group it was seen to be 27 percent. Table 1 shows the associated conditions of the 62 patients with neurosurgical problems. The results that the study found showed that the infection rate after craniotomy was 0.28 percent following ventriculoperitoneal shunt placement or ventriculostomy with a total infection rate of 0.40 percent.

Table 2 lists the pathogens recovered from CSF cultures. A total of 58 people were diagnosed with bacterial meningitis in a single episode. Four individuals with more than one episode were classified as having "recurrent meningitis."(7) The results demonstrated that out of the 58 single episodes, the most common isolated pathogens were Staphylococcus aureus, Escherichia coli, Acinetobacter baumannii, and Pseudomonas aeruginosa. The remaining 9 percent accounted for mixed infections with pathogens that were Proteus mirabilis, Escherichia coli, Citrobacter diversus, and Staphylococcus aureus.

Staphylococcus aureus strains were seen to be resistant to oxacillin and penicillin but sensitive to vancomycin in patients with polymicrobial illnesses. In 3 weeks, four patients had a recurrence of meningitis infection after the initial episodes were treated. One was infected with Citrobacter diversus and the other with Enterobacter cloacae. Another patient was infected with a combination of pathogens, which included Group D Streptococci, Enterococcus species, and coagulase-negative Staphylococcus infection. One of the other patients was infected first with Klebsiella pneumoniae and Staphylococcus saprophyticus infection. And finally, another patient has been infected with Citrobacter freundii infection.

Fever was detected in 54 of the individuals. Except for 13 individuals, everyone exhibited a disruption in their conscious state. Concomitant brain abscesses plagued three individuals, two of whom died. One patient died as a result of disseminated intravascular coagulation. In 23 of the 26 shunt-related instances, colonized shunts were removed and revised. Seven of the twenty-six individuals part of the research died. Seizures were seen to have developed in 11 of the 11 individuals, and three of the 11 died. 14 people died as a result of septic shock.

A syndrome known as the syndrome of inappropriate antidiuretic hormone (SIADH) resulted in the death of 4 patients. The second part of the research demonstrated antibiotic-resistant strains which were discovered in 29 patients with the condition of post-neurosurgical nosocomial bacterial meningitis. Out of 29, 9 were resistant strains with third-generation cephalosporin-resistant Gram-negative bacilli, while the remaining 20, were oxacillin-resistant Staphylococci. In 9 instances of third-generation cephalosporin-resistant Gram-negative bacilli, 4 were implicated with Acinetobacter baumannii, 2 with Klebsiella pneumoniae, and the remaining 2, one with Morganella morganii and another with Serratia marcescen.

Out of 20, 15 of the oxacillin-resistant Staphylococcus strains, it was Staphylococcus aureus, and in the remaining five, it was coagulase-negative Staphylococcus. The cephalosporin-resistant Gram-negative bacilli were recorded to be resistant towards ceftriaxone, ceftriaxone, moxalactam, and ceftazidime however sensitive to cilastatin/imipenem.

In 53 of the 62 patients, suitable antibiotics were utilized, according to an assessment of their antimicrobial treatment. Three individuals with concurrent brain abscesses were also operated on. Twelve individuals died out of the 53 who got proper antibiotic treatment. Nine individuals died because they did not receive proper antibiotic medication. Seven patients were administered Imipenem/cilastatin diagnosed with ceftriaxone resistant meningitis and out of which six survived however the 2 that were not provided with this treatment both expired.

Out of the 20 patients, 18 were administered Vancomycin, who were diagnosed to have oxacillin-resistant Staphylococcal strains, the remaining 2 passed away before the final culture report was given. Vancomycin was administered to 15 of the 18 patients who got it. The total mortality rate was 22% in the first half of the research and 36% in the second. There were 21 deaths and 41 survivors in total. 14 of the 21 deceased individuals died as a result of sepsis. Of the remaining 41 survivors, 22 returned to normal life or had little cognitive impairment, while the remaining 19 had serious neurological abnormalities or were in a vegetative state.

Table 1: Surgical diagnoses by which complications can occur due to meningitis

Neurosurgical conditions	n = 62
Head injury/craniotomy for trauma	16
ICH/VP shunt	11
Traumatic hydrocephalus/VP shunt	6
SICH/VP shunt	6
SICH/craniotomy	11
AVM/craniotomy	1
Cerebellar infarct/craniectomy	2
Acoustic neurinoma/craniotomy	2
SICH/ventriculostomy	3

VP = ventriculoperitoneal; SICH = spontaneous intracerebral hemorrhage; ICH = intracerebral hemorrhage; AVM = arteriovenous malformation.

Table 2: refers to post-neurosurgical nosocomial meningitis causative pathogens

Organisms	1986 - 1993 N = 9	1994-2001 N = 53	N = 62
Single episodes (N = 58) Gram-negative bacilli (N = 24)			
Pseudomonas aeruginosa	2	3(1)	5
Enterobacter species	1(1)	2	3
Morganella morganii	1	0	1
Klebsiella oxytoca	0	1	1
Escherichia coli	1	5 (2)	5
Proteus mirabilis	1	1	0
Serratia marcescens	0	1 (1)	1
Acinetobacter baumannii	1	3 (2)	4
Klebsiella pneumonia	1 (1)	2	3
Streptococcus species (N = 6)			
Mixed infection	5	4 (1)	5
Bacillus species	1	0	1
Non-A, B, D streptococci	0	2 (1)	2
Haemophilus influenzae	1	1	0
Viridans streptococci	1	0	1
Streptococcus pneumonia	0	3 (2)	3
Enterococcus	0	1 (1)	1
Staphylococcus species (N = 20)			
Coagulase-negative Staphylococcus	2	5	7
Staphylococcus aureus	2	11 (4)	13
Recurrence (N = 4)	1	3(2)	4

DISCUSSION

Although the precise generality of bacterial meningitis following neurosurgical operations and head trauma is unclear, recorded occurrences range from 0.0007 percent to 14.8 percent. This study found that the proportion of adult post-neurological nosocomial meningitis increased from 9/73 in the first group of the trial to 53/194 in the second group. Following craniotomy, the transmission rate was (35/12980) and (27/2220) after ventriculostomy or the ventriculoperitoneal shunt placement. Overall, the transmission pace was 0.40 percent.

Fever and increasing deterioration of awareness were frequent observations in the current cohort of patients, and these signals may be missed in patients with additional post-neurosurgical sequelae. As a result, if the postoperative patients were seen to develop a fever and further a gradual worsening in awareness, meningitis should be considered. CSF should be acquired as soon as possible for analysis. (8-16)

The most commonly found infectious pathogens are commensal organisms of the external auditory canal and nasopharynx in patients diagnosed with post-neurosurgical meningitis however the likelihood of nosocomial infection is recommended not to be overlooked. Aspiration of stomach contents is prevalent in individuals who have had a head injury, and it is typically worsened by bacterial super-infection. (17) A high percentage of infections has been recorded in the study caused by enteric Gram-negative germs which develop due to the regular utilization of H2 blocking medications and antacids that leads to Gram-negative aerobes and anaerobes colonizing the stomach.

In the study, a difference was recorded in the ratio of pathogens that were isolated between the two groups of the study period. The second group of the study showed an appearance of unusual pathogens such as Citrobacter freundii, Acinetobacter baumannii, Serratia marcescens, and Enterobacter species, additionally, a rise was recorded in multi-antibiotic resistance strains and polymicrobial infections. In the study, the case numbers were quite low to draw any firm reasoning but it was recorded that only imipenem/cilastatin indicated in vitro sensitivity to the resistant infections.

The recognized infectious agent seen in post-neurosurgical meningitis, specifically when intracranial implants were involved, were recognized to be coagulase-negative Staphylococcus and Staphylococcus aureus respectively. (18) The established risk components for nosocomial oxacillin-resistant Staphylococcus infections before antibiotic medication consider nasogastric tube installation and urinary catheterization. The research helped in identifying the increment in the incidence of oxacillin-resistant Staphylococcus infection in post-neurosurgical nosocomial meningitis of the latter group which was seen to be consistent with the rapid spread in Taiwan of Staphylococcus species with classic oxacillin resistance particularly found existing in individuals diagnosed with nosocomial infections. (19)

There have been few clinical trials for the treatment of oxacillin-resistant Staphylococcus meningitis using vancomycin. Normally, vancomycin wasn't seen enter into the CSF much in the absence of meningeal irritation, however, when meningitis occurs, the solution can be moderately increased. For the treatment of meningitis caused by Staphylococcus species with penicillin resistance, several therapeutic regimens have been utilized including nafcillin plus rifampicin, linezolid, intrathecal vancomycin therapy, and vancomycin plus rifampicin. In this study, the adult patients were treated with intravenous vancomycin infusion who was diagnosed with meningitis.

Modern research of nosocomial meningitis in neurological patients from the European population looked at postoperative plus posttraumatic meningitis and found a 39.06 percent fatality rate. In another research, posttraumatic meningitis was classified as a non-fatal consequence of a brain injury. The total mortality rate in this trial was 34%. Even with the breakthroughs in current neurosurgery methods, antibiotics, and imaging tools, the rate of death appears to be rising. (20) The higher death rates in this study might be attributed to both underlying

brain pathology and impaired CSF sterilization as a result of antibiotic-resistant bacteria.

CONCLUSION

There has emerged a significant sub-type of bacterial meningitis that manifests in a hospital environment which is known as adult post-neurosurgical nosocomial meningitis. Diagnosis has been made challenging due to the lack of specificity of laboratory and clinical signs. Fatality rates have spiked in the group of patients suffering from strains that are resistant to multi-antibiotic and additionally, poly-microbial infections have complicated therapy, even with the commencement of newer antibiotics for the management of bacterial meningitis. The selection of appropriate empirical antibiotics is complex and is necessary to be guided by knowledge of the comparative ratio of multiple diseases as well as the rising prevalence of resistant strains. To increase the likelihood of survival, early diagnosis is suggested with optimal antibiotic selection based on in vitro susceptibility testing, epidemiologic patterns, and lastly, metabolic derangement treatment to be advised and required.

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